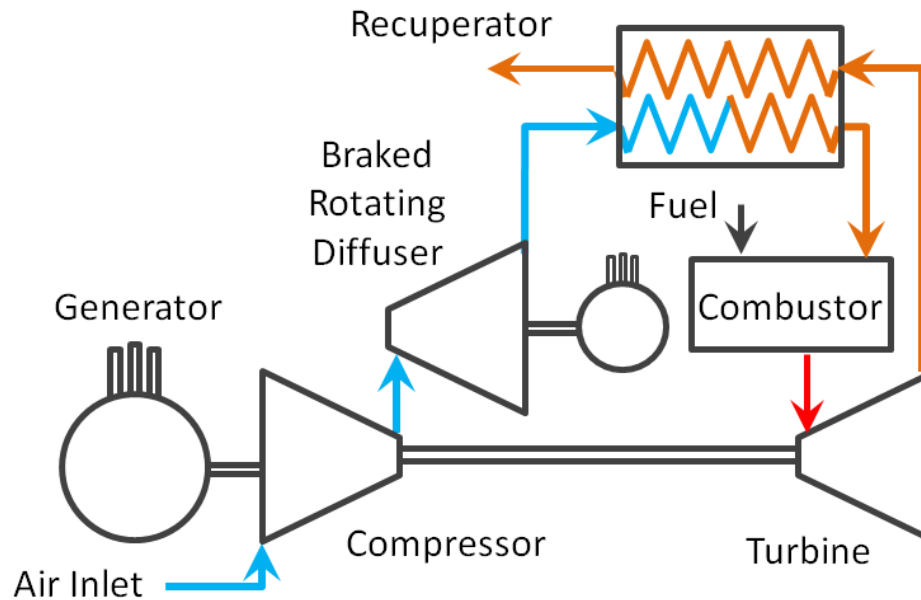


Metis Design Corporation: GENSETS Team



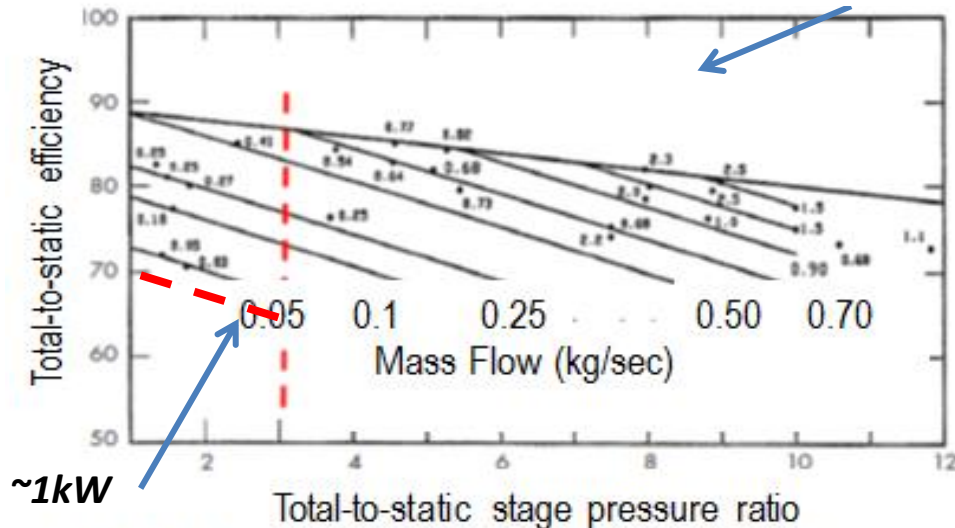
Lawrence Berkeley
National Laboratory



Metis 1kW Microturbine System

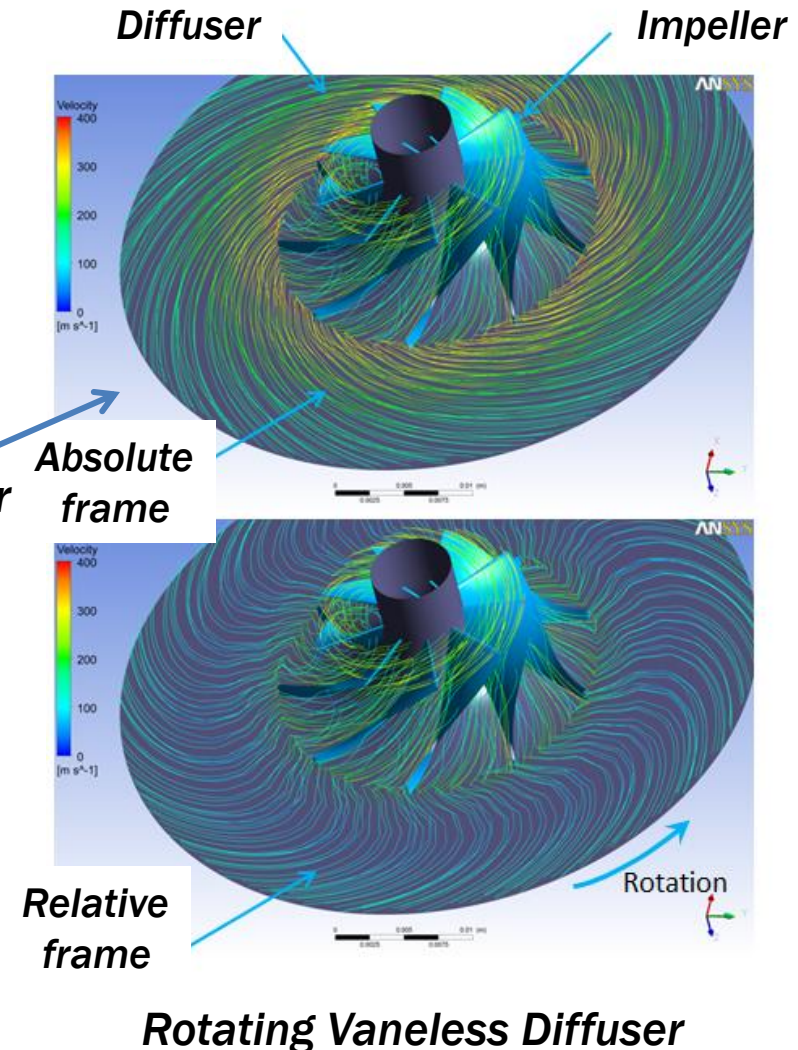
Turbomachinery Innovation: Rotating Vaneless Diffuser

- ~50% impeller / 50% diffuser pressure rise
- ~80% impeller pressure rise comes from loss free centrifugal acceleration
- Diffusers are very lossy ($\text{loss} \propto V^3$)
- Rotating diffuser relative velocity & streamtube length can be halved
- Tested at 2x GENSETS pressure ratio at 6x scale for DARPA



Centrifugal compressor design-point performance

SOA
Compressor

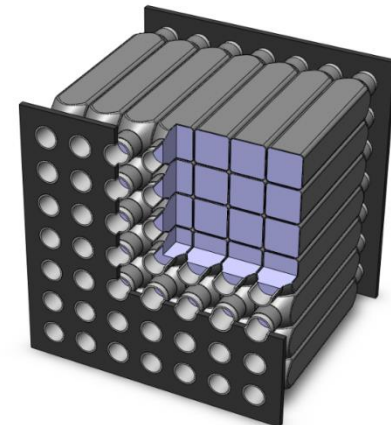
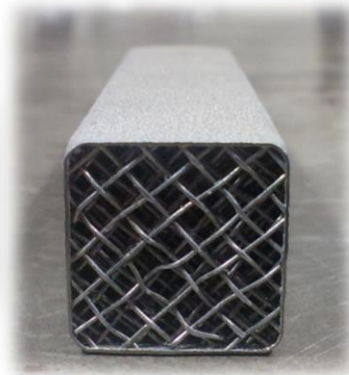


Rotating Vaneless Diffuser

High Effectiveness Recuperator

Ultra-Compact Heat Exchanger

- Simple to tailor the specific surface area and hydraulic diameter
- Orthotropic nature of screen virtually eliminates axial conduction losses
- Process allows for almost any final shape and enhanced microturbine integration potential



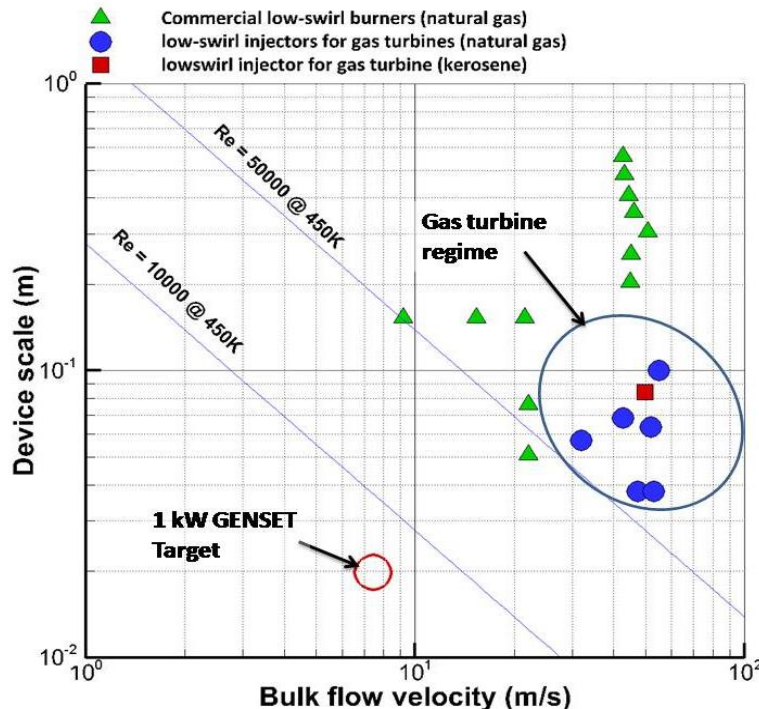
Net-Shape Additive Manufacturing

- External heat transfer surface is sprayed in its final state – no post-processing
- Flexible material options – allows for a functional gradient of materials by changing powder and screen materials

1 kW Microturbine Combustor Development

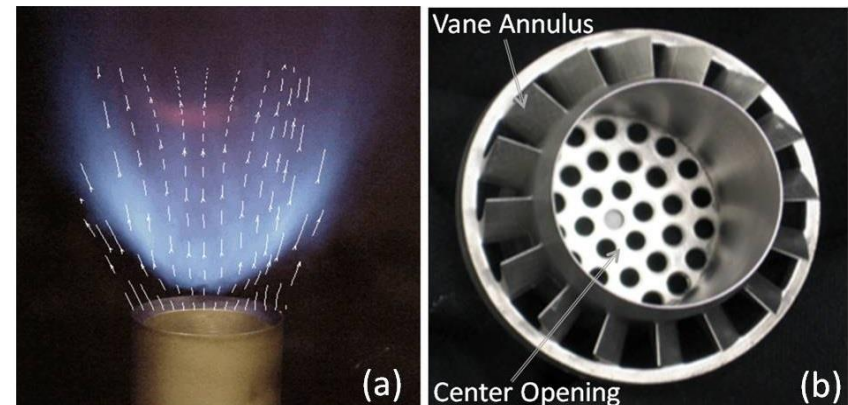
Challenge

- 1 kWe micro-turbine GENSET combustor operates at the laminar to turbulent transition flow regimes
- Advanced ultra-low emissions combustion technologies are for fully developed turbulent flows



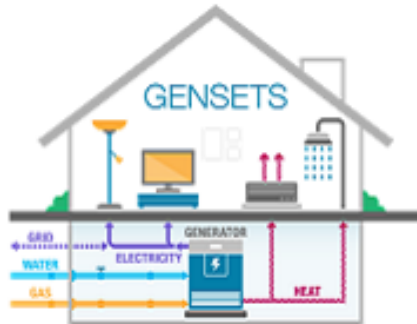
Solution

- Scale the **Low-swirl burner (LSB)** technology for the transitional flow regime
 - Demonstrated atmospheric operation in flow transition region
 - Prior developments for 30 kW to 200 MW gas turbines
- Simple and highly scalable design offers cost-effectiveness and efficiency enhancement opportunity



(a) Flowlines measured through a LSB flame show the divergent flow central to its operation, (b) the patented LSB swirler

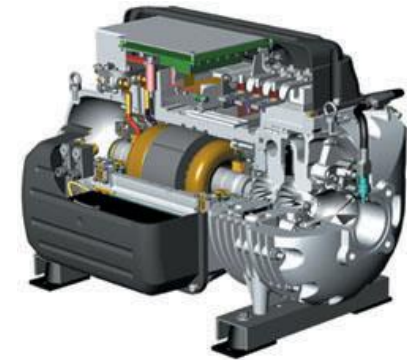
Impact 1kW Microturbine Development



**GENSETS
microturbine
system**



**Lightweight power
system for
UAVs/Drones**



**Improved small
scale refrigeration
compressors**

Resources, technical expertise, market knowledge and connections

- Additional resources & technical expertise for the integration of foil bearings and high temperature turbine materials
- Market knowledge and connections in AC/refrigeration industry